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(54) **Transmitter/receiver isolation circuit**

(57) In order to isolate receiver circuitry (20) in a radio communications device from a signal (14) transmitted by the same device, the pass band of a variable pass band filter (24) defining the reception frequency is shifted away from the transmission frequency during transmission.

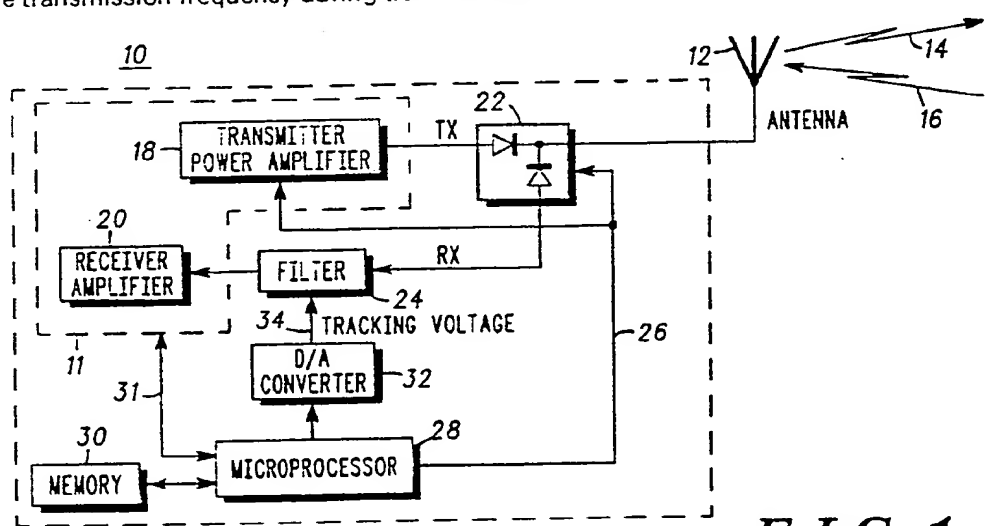

FIG.1
— PRIOR ART —

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

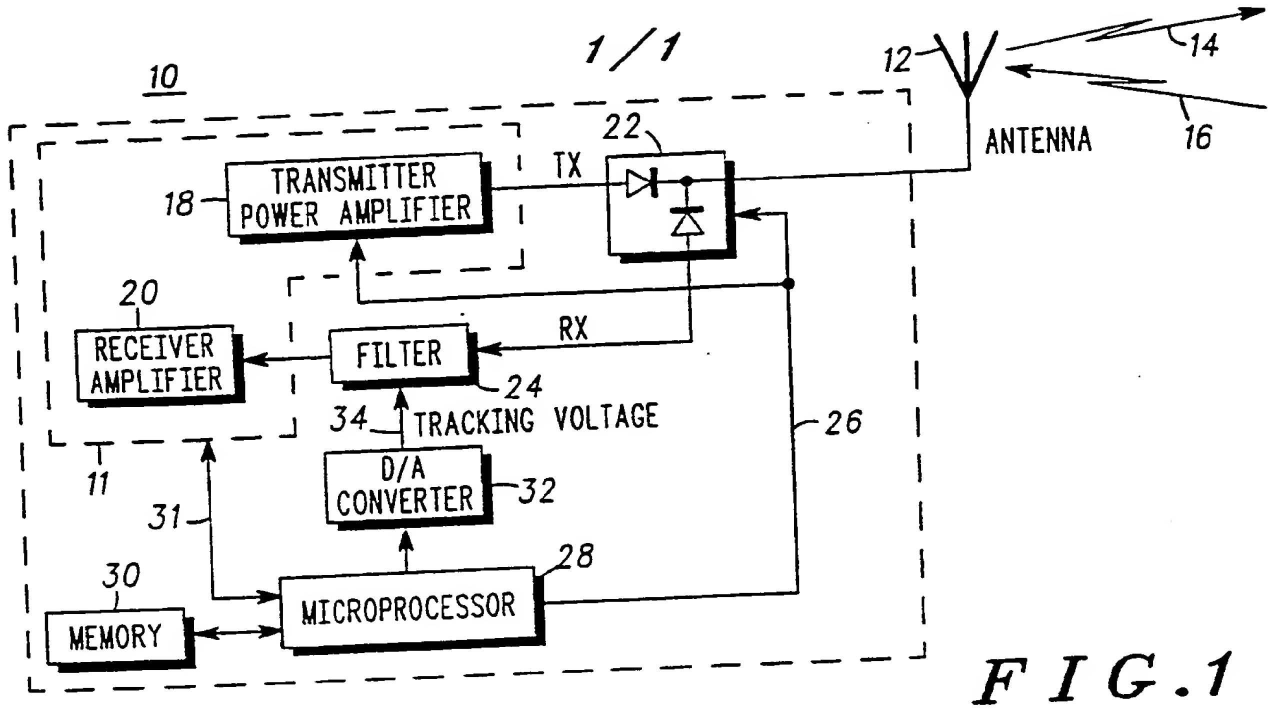

FIG.1
— PRIOR ART —

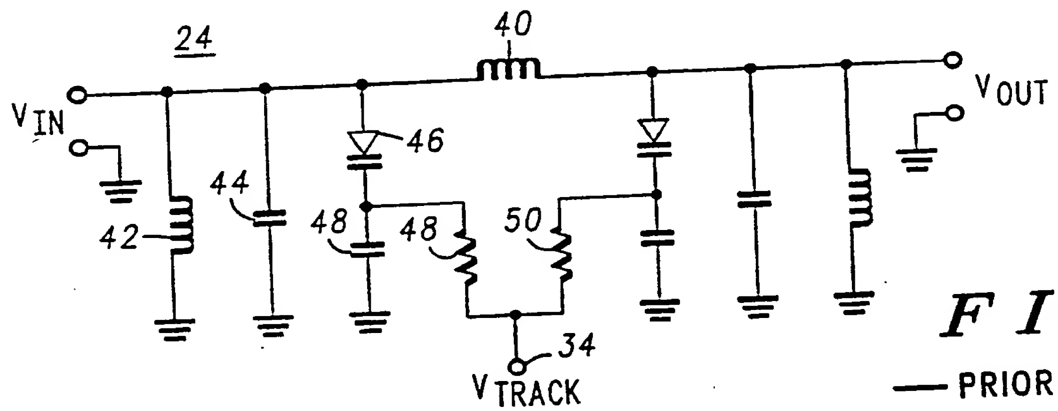

FIG.2
— PRIOR ART —

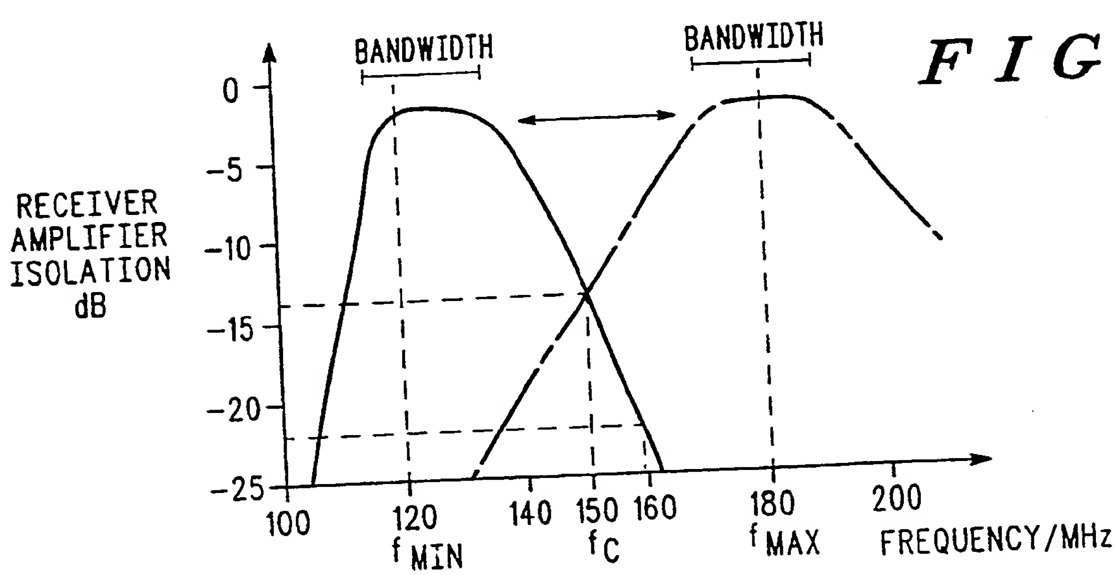

FIG.3

An Isolation Circuit and Method of Operation thereof.

Background to the Invention.

This invention relates, in general, to isolation circuits for radio communication devices and is particularly, but not exclusively, applicable to isolation circuits incorporating filters to isolate sensitive receiver circuitry, during a transmission operating mode of the radio communications device, from a high power path between a transmitter and an antenna of the device.

Summary of the Prior Art

In a transmission mode of a radio communications device, an antenna of the device is switched to a power amplifier of a transmitter section of the device whilst being broadband isolated from the device's receiver circuitry. The switching and isolation is achieved through an antenna switching (or isolation) network, typically containing a PIN diode switch. Such PIN diode switches isolate the receiver circuitry by ~-25dB of radio frequency power per PIN diode switch. In order to protect the receiver circuitry from damage, an isolation network is utilised in collaboration with a tuned radio frequency preselector filter.

Since a PIN diode switch configuration is only able to isolate the receiver circuitry ~ -25dB, more elaborate circuitry, such as cascade of isolation circuits, is required to achieve greater isolation. In addition to the elaborate architecture required to achieve greater Rx isolation, there is a corresponding increase in the cost of the isolation circuit.

It will be appreciated that there is a requirement in the art to provide a simple, low cost isolation network that can add a high degree of Rx isolation.

Summary of the Invention.

In accordance with the present invention, there is provided an isolation circuit an isolation circuit for a radio communications device for selectively coupling and isolating, during the reception

and transmission of radio signals respectively, a radio signal to and from receiver circuitry, the isolation circuit comprising: a frequency selectable filter having a passband, narrower than an operating frequency range for the radio communications device, that is controllably shiftable along the operating frequency range and tunable to selected receive frequencies therein; and frequency selection means, coupled to the frequency selectable filter and responsive to the reception and transmission of a radio signal, for shifting the passband of the frequency selectable filter to and from a selected receive frequency dependent on the reception and transmission respectively of radio signals; wherein the frequency selection means shifts the passband, in response to the transmission of a radio signal at a transmission frequency for the radio communications device, to a second receive frequency having an increased frequency separation between the receive frequency and the transmission frequency, thereby increasing an isolation of a transmitted radio signal from the receiver circuitry.

In a preferred embodiment, the frequency selection means shifts the passband, during transmission of a radio signal, to a frequency at an extreme end of an operating frequency range of the radio communications device. Furthermore, the isolation circuit further isolates the receiver circuitry from the transmitted radio signal by at least -10dB. During transmission of a radio signal, the passband can be shifted to a frequency outside an operating frequency range of the radio communications device or to a frequency, in a direction of the receive frequency, having a frequency separation from the transmission frequency greater than the frequency separation of the receive frequency from the transmission frequency.

In a further aspect of the invnetion, there is provided a method of selectively isolating a transmitted radio signal from receiver circuitry in a communications device, comprising the steps of: identifying that transmission of a radio signal is about to commence; determining a first frequency, in an operating frequency range of the radio communications device, at which the radio signal is to be transmitted; shifting a passband of a preselector RF filter to a second frequency, in the operating range, having a frequency separation from the first frequency, thereby isolating the receiver

circuitry from a transmitted radio signal; and transmitting a radio signal at the first frequency.

In this preferred aspect, the method may further comprise the steps of: defining a frequency boundary approximately at a mid-point in the operating frequency range; determining on which side of the frequency boundary the first frequency is; and shifting the passband of the preselector RF filter to an extreme end of the operating frequency range on the other side of the frequency boundary.

An exemplary embodiment of the present invention will now be described with reference to the accompanying drawings.

Brief Description of the Drawings.

Fig. 1 shows a prior art radio communications device.

Fig. 2 shows a typical varicap tuned and tracked radio frequency preselector filter circuit.

Fig. 3 illustrates a filter characteristic for a variable tracking filter constructed in accordance with the present invention and suitable for implementation in Fig. 1.

A Preferred Embodiment of the Present Invention.

With reference to Fig. 1, there is shown a schematic diagram of a typical radio communications device 10 having a microprocessor controlled transceiver 11. The communications device 10 includes an antenna 12 for transmitting signals 14 and receiving signals 16. The antenna 12 is coupled to either transmitter circuitry (represented by the transmitter power amplifier 18) or receiver circuitry (represented by a receiver amplifier 20) through an isolation or switching circuit 22, such as a PIN diode switch. As will be appreciated, the PIN diode switch is constructed in accordance with techniques know to one skilled in the art, and is used to isolate, during a transmission mode for the communications device, receiver circuitry of the communications device 10 from the transmitter power amplifier 18. The Rx amplifier 20 is coupled to the isolating circuit through a preselector filter 24. The isolating circuit 22 is responsive to a control signal 26 generated from a microprocessor

28. The control signal is used to control the isolating circuit 22, e.g. by selectively causing forward biasing of one of a plurality of PIN diodes located therein. The microprocessor 28 is coupled to memory 30, such as read only memory (ROM). The microprocessor 28 controllable selects an operational mode for the transceiver 11 through control line 31. Furthermore, the microprocessor 28 controls the tracking of the filter 24 by supplying, through a D-A converter 32,.a tracking voltage 34.

Turning to Fig. 2, a varicap tuned and tracked RF preselector filter, suitable for implementation as block 24 in Fig. 1, is shown. The preselector filter 24 is tuneable, for example, over a VHF range of 130MHz-180MHz, i.e. its filter characteristic can be adjusted so to be centred on a central frequency f_c that is within the range of frequencies $f_{min} \leq f_c < f_{max}$. The frequencies f_{min} and f_{max} represent the lower and upper operating frequencies for the radio communications device 10.

The preselector filter has a voltage input V_{track} responsive to the tracking voltage 34. A voltage, applied to an input terminal V_{in}, is communicated through the preselector filter 24 to an output terminal V_{out}. An inductor 40 is coupled between the input terminal V_{in} and the output terminal V_{out}. Coupled between the input terminal V_{in} and the inductor 40 is a three-armed, parallel configuration of an inductor 42 a capacitor 44 and a series combination of a varactor diode 46 and a further capacitor 48. The anode of the varactor diode is coupled to the inductor 40 whilst the cathode of the capacitor is coupled to ground potential. A first resistor is coupled between the tracking input V_{track} and a circuit node between the varactor diode 46 and capacitor 48. A similar three-armed, parallel configuration is coupled between the other end of inductor 40 and the output terminal V_{out}. The tracking input V_{track} is coupled to this second arm of the RF preselector filter 24 through a second resistor 50. Coupling of the second resistor 50 is achieved in an identical manner to that previously described for the first resistor 48. It will be appreciated that the filter of the preferred embodiment can be replaced by any suitable frequency controllable filter having a varactor tuneable bandpass.

As will be appreciated, the transceiver (not shown) of the radio communications device 10 tracks the RF preselector filter 24

over its switchable bandwidth from f_{min} to f_{max}. Tracking by the transceiver, and more specifically its receiver section, is controlled by the microprocessor 28. More specifically, the microprocessor outputs the tracking voltage 34 to the filter 24 through the D-A converter 32 during a receive mode of the radio communications device 10. It is the application of this tracking voltage to the filter, during the receive mode, that controls the frequency at which the filter characteristic is centralised. It will be appreciated that the centralised frequency of the preselector filter 24 has no affect on a transmitted signal during the transmit mode. It will further be appreciated that the tracking voltage is derived by the microprocessor in accordance with techniques known to one skilled in the art.

In accordance with the present invention, transmitter power isolation to the RX amplifier 20 during transmitter operation is increased by altering the frequency at which the filter characteristic is centralised. More specifically, the frequency at which the filter characteristic is centralised f_c is shifted to an extreme edge F_{min} or F_{max} of the operating range of the radio communications device 10. This can best be illustrated with reference to Fig. 3. If we consider a radio communications device 10 to have an operating range between 120MHz and 180MHz, a typical preselector filter bandwidth (or passband) will be ~10MHz. As will be appreciated, the midpoint frequency between 120MHz and 180MHz is 150MHz. In the event that the transmitter is transmitted at a frequency above 150MHz, the filter characteristic of the preselector filter 24 is centralised on the minimum operating frequency for the radio communications device, i.e. 120MHz. Alternatively, if the radio communications device 10 is transmitting at a frequency below 150MHz, the filter characteristic of the preselector filter 24 is centralised on the upper operating limit of the radio communications device 10, i.e. 180MHz. In the example, 150MHz has been selected as a arbitrary boundary in the operating range of the communications device. The choice of frequency at which the decision to shift the filter characteristic is made is basically dependent on the exact shape of the filter characteristic. Therefore, the defining frequency can be anywhere in the operating range of the radio communications device 10. If the filter characteristic is symmetrical, then a mid-point in the operating

range would be a sensible choice. Clearly, with the preselector filter shifted away from a desired transmission frequency by centralising the filter characteristic at an extreme operating end of the operating range, greater RX amplifier isolation is achieved. More specifically, the repositioning of the filter characteristic of the preselector filter reduces overlap between the pass band of the filter and the actual transmission frequency. For example, if the preselector filter characteristic is centralised (repositioned) at 120MHz and the transmitter is transmitting at 150MHz, the RX amplifier isolation is at least -13dB. Alternatively, if the filter characteristic of the preselector filter 24 is centralised at 120MHz, and the transmission frequency is, say, 158MHz the RX amplifier isolation increases to ~ -22.5dB. The isolation will, of course, vary according to the filter characteristic and will typically provide isolation of better than -10dB and typically -25dB.

It will further be appreciated that the memory 30 of the radio communications device 10 could store information pertaining to the shape of the filter characteristic of the preselector filter and the microprocessor 28 could select the centralisation of the filter characteristic to achieve a maximum Rx amplifier isolation.

As will be appreciated, an invention so designed and described produces the novel advantages of a Rx-Tx isolation network with simplified design at reduced cost. Moreover, the invention provides an increased Rx amplifier isolation through de-tuning of a filter characteristic of a preselector filter in a radio communications device. It will further be appreciated that the improvement in Rx amplifier isolation has the desirable benefit that there is a corresponding increase in the life expectancy of components in an Rx stage that arises from a reduced thermal power stress in those components. In addition, implementation of the invention reduces the demand for high Rx-Tx PIN diode isolation. Moreover, the invention may in certain circumstances, such as in low power portable radio communciation device applications, make the use of prior art PIN diode isolation circuits or the like redundant, thereby allowing the complete removal of such circuits from the electrical device.

It will be appreciated that the above description has been given by way of example only and that modifications in detail may

be made within the scope of the invention. For example, the passband of the filter characteristic need not be exactly centralised on an extreme operating limit for the radio communications device. Clearly, for a filter characteristic with a passband that is not particularly uniform in nature, an offset may be more desirable; and therefore not centralised. In addition, the circuit could be used, for example, to isolate a signal generator receiver section from overload and also to improve the performance of measurement equipment through improved isolation thereof.

Claims.

1. An isolation circuit (24, 28, 32) for a radio communications device (10) for selectively coupling and isolating, during the reception (16) and transmission (14) of radio signals respectively, a radio signal to and from receiver circuitry (20), the isolation circuit comprising:

a) a frequency selectable filter having a passband, narrower than an operating frequency range for the radio communications device, that is controllably shiftable along the operating frequency range and tunable to selected receive frequencies therein; and

b) frequency selection means, coupled to the frequency selectable filter and responsive to the reception and transmission of a radio signal, for shifting the passband of the frequency selectable filter to and from a selected receive frequency dependent on the reception and transmission respectively of radio signals;

wherein the frequency selection means shifts the passband, in response to the transmission of a radio signal at a transmission frequency for the radio communications device, to a second receive frequency having an increased frequency separation between the receive frequency and the transmission frequency, thereby increasing an isolation of a transmitted radio signal from the receiver circuitry (20).

2. An isolation circuit (24, 28, 32) in accordance with claim 1, wherein the frequency selection means shifts the passband, during transmission of a radio signal, to a frequency at an extreme end (f_{min}, f_{max}) of an operating frequency range of the radio communications device (10).

3.. An isolation circuit (24, 28, 32) in accordance with claim 1 or 2, wherein the isolation circuit further isolates the receiver circuitry (20) from the transmitted radio signal by at least -10dB.

4. An isolation circuit (24, 28, 32) in accordance with claim 1, 2 or 3, wherein the isolation circuit further isolates the receiver circuitry (20) from the transmitted radio signal by at least -25dB.

5. An isolation circuit (24, 28, 32) in accordance with any preceding claim, wherein the frequency selection means shifts the passband, during transmission of a radio signal, to a frequency outside an operating frequency range of the radio communications device (10).

6. An isolation circuit (24, 28, 32) in accordance with any preceding claim, wherein the frequency selection means shifts the passband in the direction of the receive frequency, during transmission of a radio signal, to a frequency having a frequency separation from the transmission frequency greater than the frequency separation of the receive frequency from the transmission frequency.

7. A method of selectively isolating a transmitted radio signal from receiver circuitry (20) in a communications device, comprising the steps of:

a) identifying that transmission of a radio signal is about to commence;

b) determining a first frequency, in an operating frequency range of the radio communications device, at which the radio signal is to be transmitted;

c) shifting a passband of a preselector RF filter to a second frequency, in the operating range, having a frequency separation from the first frequency, thereby isolating the receiver circuitry from a transmitted radio signal; and

d) transmitting a radio signal at the first frequency.

8. The method of selectively isolating a transmitted radio signal from receiver circuitry in accordance with claim 7, further comprising the steps of:

a) defining a frequency boundary approximately at a mid-point in the operating frequency range;

b) determining on which side of the frequency boundary the first frequency is; and

c) shifting the passband of the preselector RF filter to an extreme end of the operating frequency range on the other side of the frequency boundary.

9. An isolation circuit substantially as described herein with reference to Fig. 3.

10. A method of selectively isolating a transmitted radio signal from receiver circuitry (20) in a communications device substantially as described herein with reference to Fig. 3.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

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Relevant Technical fields

(i) UK Cl (Edition L) H4L (LECP, LECSX)

(ii) Int Cl (Edition 5) H04B, 1/44, 1/48, 1/50, 1/54

Search Examiner

N W HALL

Databases (see over)

(i) UK Patent Office

(ii) ONLINE : WPI

Date of Search

7 MAY 1993

Documents considered relevant following a search in respect of claims 1-10

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	EP 0287671 A1 (MATSUSHITA) - whole document	

Category	Identity of document and relevant passages 12.	Relevant to claim(s)

Categories of documents

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